GROUND WATER POLLUTION IN THE JAFFNA PENINSULA

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1. INTRODUCTION :

Water is with the exception of air, the most important single substance to man's survival. About three quarters of the earth surface is covered with water but about 97.4 percent of it is salt water in the oceans and about 1.8 percent frozen in the polar regions. Fresh water needed by human beings to sustain life, health and productive activities constitute only 0.8 percent of the world's supply and probably a large proportion of this is contaminated and is affecting the well being of the people.

Adequate supply of safe drinking water is a primary requirement for improving the public health in the developing world of today. Other important use of water are for agriculture, industries and recreation. Thus looking to the vast requirements on one hand and its limited availablity on the other hand, all out efforts are needed to conserve this valuable commodity and protect it from getting polluted.

2. TYPES OF POLLUTION :

Quality of the water in a well is determined by the character of the near by catchment area.

1. Pollution by Bacteria
2. Pollution by Fertilizer
3. Pollution by Pesticides
4. Pollution by Industrial waste
5. Pollution by Rubbish tips
6. Pollution by Manure heaps
7. Pollution by Over Pumping
8. Pollution from burial grounds

2.1.1. Pollution by Bacteria.

Methods of human eccreta disposal includes non-water carried arrangements such as pits, and on site disposal such as septic tanks. In such cases a "safe distance" should be defined for each and every latrine. In limestone area like Jaffna where pit latrines are used faecal coliforms were detected in wells which are about 40 - 50 ft from the latrine. The reason being in limestone areas pollution travels in channels and flow more quickly into the water table. Pollution is more during the rainy season.

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Table I

	Distance of well from latrine	E.coli in 100 ml sample
Kankesanturai	10 ft.	542
	20 ft.	348
	30 ft.	172
	40 ft.	141
	50 ft.	58
	70 ft.	17
	90 ft.	8
	100 ft.	1

Safe distance in a limestone area is about 100 ft. In the case of clayey soil bacterial retention is better and the safe distance, could be about 50 ft.

2.1.2. Pollution by Fertilizer.

There is increasing evidence that the rise in nitrate concentration in ground water primarily due to agricultural activities such as the application of nitrogen as fertilizers at rates inexcess of the take up rate by crops. In the Jaffna district where an intensive use of fertilizer is procticed high nitrate contents were detected. The allowable maximam limit of nitrogen in the drinking water is 10 mg/l. The table given below gives the nitragen concentration in various places in Jaffna District.

Table II

Projected Concentration of Nitrogen in Ground Water.

Agicultural Service Centre	Natrogen Concentration (mg/l)				
	1982	1985	1990	1995	2000
Pallai	11.8	13.8	14.3	15.1	16.0
Chavakachcheri	12.0	12.5	13.6	13.9	14.5
Nallur	10.2	10.4	11.1	11.7	12.4
Velanai	6.5	6.8	7.1	7.4	7.6
Tholpuram	16.1	16.6	17.6	18.1	18.6
Keeremalai	37.4	48.3	43.2	44.7	45.4
Uduvil	22.0	23.5	25.1	26.1	26.6
Puttur	24.9	26.3	27.3	28.0	28.5
Puloly	9.4	18.6	11.8	12.5	13.3
	14.8	16.2	17.2	17.8	18.2
Kaithady	9.2	10.8	12.1	12.9	13.4
Pungudutivu	9.9	12.8	16.1	18.8	20.8
Average	13.5	14.6	15.8	16.6	17.1

2.1.3. Pollution by Pesticides

There are three groups of pesticides available for control of pests. They are :

I.	Organochlorine	eg.	D.D.T
II.	Organophosphates	eg.	Malathion
III.	Carbamates	eg.	Carbofuran

Organochlorines persist long in soils, water, plants and animal waste. Despite their less solubility they are extremely toxic. Most of the organochlorines are strongly absorbed on soils and hence threat to ground water quality is limited. However, they can move through leaching.

Organophosphates although very toxic degrade relatively quickly in biological systems. Organophosphates may move great distances underground compared to organochlorines.

Carbamates are relatively new and little is known about their behaviour in the ground. However, like organophosphates they are less persistent in the environment.

Studies have revealed that farmers use more than the recommended dosage and that such pesticides enter ground water by percolation.

2.1.4. Industrial Waste:

Industrial waste are potentially as varied as the industries from which they stem. The untreated effluents are descharged, on th the land and this pollute the ground water. In Jaffna the coconut husk and fibres are stored in the ground. These rot and pollute the ground water.

2.1.5. Rubbish Tips

Dumping of rubbish is practiced in both rural and urban areas. In these places anaerobic reaction takes place. Here there is a formation of polluting liquor called "leachate". Leachates are formed by liquids, principally water which percolates through the wastes and which become changed with potential pollutants by direct solution of certain compounds.

2.1.6. Manure heaps

Generally cattle manure and poultry waste are stored in heaps as manure. This decays and forms mainly nitrate. This nitrate pollutes the underground water.

2.1.7. Over Pumping:

Sea water intrusion occurs when there is over pumping. This could be prevented

(1) by reducing the total abstraction
(2) by pumping from large number of low yielding bore holes
(3) by pumping from shallow wells and addicts.

2.1.8. Pollution from burial grounds:

Pollution is mainly by organic matter.

3. Pollution control measure:

Once pollution has occured it requires many years and a great deal of expense to repair the damage. Even then complete recovery may be impossible. Thus advance prevention of pollution should be sought. Therefore, an act called "control of pollution", should be passed by the relevant Authority must work in conjunction with the water Authority to control the pollution in ground water.

3.1. Water quality standards:

Standards have been formulated for drinking water, Industrial water, propagation of fish and other auquatic organisims and recreation. Drinking water standards has been formulated by the W.H.O and Sri Lanka. Water pollution could be controlled to some extent by enforcing these standards.

The water quality standards are given in Annexur I, ~~a,b,c,d~~ Table I, II, III and Annexure II & III

3.2. Effluent Standards:

Industries such as textile industry, canning, prawn processing, confectionaries, discharge their effluents onto land. There is no proper effluent treatment. Therefore, infuture for all the factories an Authority should insist on an Environmental Impact Assessment as this is a powerful tool in the prevention of environmental pollution. Effluent standards should be strictly enforced. The indian effluent standard is given in Annexure IV.

3.3 Improvement of sewage disposal:

In places where houses are constructed very closely, improved sewage disposal system should be recommended.

3.4 Realisation of a pleasant Environment:

General public should be made to realise the importa-nce of a pleasant Environment. During the " Environment Week" importance of water Quality, Effluent disposal, proper method of sewage disposal should be made public through mass media, Exhibitions etc. School children should be made to take and active part. An awareness should be created among the public.

4. Recommendation:

The water Authority must identify the aquifers which are important for water supply system and demarcate the areas and safe guard the areas. They should practice the following pollution polices in safe guarding the above areas.

1) No waste disposal
2) No burial grounds
3) No main foul sewers except some approved material
4) No industrial development
5) No intensive animal farm
6) No large manure heaps
7) No farm drainage

8) No excessive application of pesticides and insecticides
9) No disposal of sewerage sludge in land
10) No dischagge of surface water into the aquifer if there is a risk of water being polluted.

Annexure I SPECIFICATION FOR POTABLE WATER

(SRI LANKA STANDARD)

Table I

Physical Requirements

Characterstic	Maximum Desirable	Maximum Permissible
Colour	5 units	30 units
Odour	Unobjectionable	Unobjectionable
Taste	Unobjectionable	Unobjectionable
Turbidity J.T.U.	2	8

Table II

CHEMICAL REQUIREMENTS BASIC

Substances or Characteristics	Maxium Desirable Level	Maxium Permissibles
PH ranch	7.0 - 8.7	6.5 - 9.0
Electrical Conductivity	750/s/cm	3500 s/cm
Chloride	200mg/1	1200mg/1
Free Residual Chlorine	-	0.2mg/1
Alkalinity as $CaCo_3$	200mg/1	400mg/1
Free Ammonia	-	0.06mg/1
Albuminoid Ammonia	-	0.15mg/1
Nitrate as N	-	10mg/1
Nitrite as N	-	0.01mg/1
Fluoride as F	0.6mg/1	1.5mg/1
Total Phosphates as PO_4	-	0.2mg/1
Total Residue	500mg/1	2000mg/1
Total Hardness as $CaCo_3$	250mg/1	600mg/1
Total Iron as Fe	0.3mg/1	1.0mg/1
Sulphates as So_4	200mg/1	400mg/1

Table III

CHEMICAL REQUIREMENTS (OPTIONAL)

Substances or Characteristics	Maxium Desirable Level	Maxium Permissibile Level
Amonic Detergents	0.2mg/1	1.0mg/1
Phenolic Compunds (as Phenolic OH)	0.001mg/1	0.002mg/1
Grease and Oil	-	1.0mg/1
Calcium as Ca	100mg/1	240mg/1
Copper as Cu	0.05mg/1	1.5mg/1
Manganess as Ma	0.05mg/1	0.5mg/1
Zinc as Zn	5.0mg/1	15mg/1
Aluminium as Al	-	0.2mg/1
Pesticide residue	-	as per WHO/FAO requirements
C.O.D	-	10mg/1
Magnesium	Not more than an 30mg/1 if there are 250mg/1 of Sulphate. If there is less Sulphate Magnesium up to 150mg/1 may be allowed.	140mg/1

Annexure II

W.H.O INTERNATIONAL STANDARDS

Toxic Substances

Substances Lead	Maximum Allowable Concent -ration mgs/1
Arsenic	0.05
Selenuim	0.05
Chromium (hexavalent)	0.01
Cyanide	0.2
Cadmium	0.01
Barium	1.0
Phenolic substances	0.002

Substances which may affect Health:

Substances	Maxium Allowable Concent ration mgs/1
Fluorides	1.5
Nitrates as No_3	~~45~~ 45

Chemical Indicators of Pollution:

	Maximum Limits mg/1
Chemical oxygen demand (C.O.D)	10
Biochomical oxygen demand (B.O.D)	6
Total Nitrogen exclusive of No_3	1
Ammonia	0.5
Carbon Chloroform extract	0.5
Grease	1

Annexure III

CHEMICAL SUBSTANCES AFFECTING POTABILITY OF WATER

	Maximum Acceptable Conc mgs/1	Maximum Allowable Conc mgs/1
Total Solide	500	1500
Colour (Hazen)	5	50
Tubidity (J.T.U)	2	10
Taste	Unobjectionable	Unobjectionable
Odour	Unobjectionable	Unobjectionable
Iorn Fe	0.3	1.0
Manganse Mn	0.1	0.5
Copper Cu	1.0	1.5
Zinc Zn	5.0	15
Calcium Ca	75	200
Magnesium Mg	50	150
Sulphates So_4	200	400
Chlorides Cl	200	600
PH	7.0 - 8.5	6.5 - 9.2
Total Hardnes	100	500

Annexure IV

STANDARDS FOR THE EFFLUENTS TO BE DISCHARGED ON LAND

(INDIAN STANDARDS)

	MGS/1
1. PH	5.5 - 9.0
2. Total dissolved solids	2100
3. Sulphates	1000
4. Chlorides	600
5. Percent Sodium	60
6. Biochemical oxygen demand	200
7. Oil & greass	20
8. Boron as B	2
9. Cyanides as CN	5
10. Total Chromium as Cr	2.5
11. Hexaralent Chromium as Cr	1.0
12. Zinc as Zn	10
13. Ammonical Nitrogen as N	100
14. Copper as Cu	3
15. Nickel as Ni	3
16. Total Mercury	0.01
17. Selenium as Se	0.1
18. Lead as pb	0.5
19. Arsenic as As	0.5
20. Cadmuin as Cd	5.0
21. Radio active materials	
Alpha emitters uc/ml	10^{-9}
Beta emitters uc/ml	10^{-8}

Drainage as part of Environment

By. M.Thillainathan.

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(1) Ecology and Environment

(1) Ecology is the study of the relationship and interactions of the living and non-living parts of our surroundings. The living parts include plants, animals and one celled organisms such as bacteria and algae while weather, soil rocks, energey, topography and water are some of the non-living elements in our surroundings. All these factors are inter-related and that it is impossible to alter one part of our surroundings without producing changes in another part.

Environment is surroundings involving all living and non-living parts. Therefore Ecology is the study of environment.

The natural environment is a term used to describe systems which have evolved over millions of years, approaching a harmonious, but dynamic balance. In natural systems water cycles, soil fertility, plant - animal relationships tend to be stable and predictable, although often upset by natural catastrophes such as earthquakes, floods etc.

Man has the ability to alter significant parts of a system leading to artifical environments such a cities, farms and lakes. These artificial environments contain benifits but also may create unfavourable conditions: increased diseases, contaminated water supplies, deforestation, desertification and eroded soils.

If artificial enviornments can be made to function more like natural environments, they tend to be more stable and predict able. An understanding of the functioning of a natural system, is necessary to ensure that stability and long lasting benefits are preserved in the artificial environment.

The smaller units within the ecological systec are called ecosystem.

e.g: types of vegetation, amount of rainfoll, topography etc.

(2) Hydrological Cycle

Part of the circulation of energy in the atmosphere which produces the different climates of the world involves water in its three main states: Solid, Liquid and Gas. The atmospheric engine driven by the sun absorbs water vapour mainly from the oceans, dumps it all over as rainfall which finds it's way back to the ocean through rivers and streams. The circulation of water between atmosphere, land and ocean is known as the hydrological cycle.

The turnover time of moisture in each of the temporary stores of the hydrological cycle varies, the most dynamic part of the cycle is the atmosphere. The most dormant part of the cycle is the ocean. The land phase of hydrological cycle is the most diverse in spite of the small quantities involved.

(3) Hydrology

Hydrology is the study of circulation of water between atmosphere, land and ocean. The hydrology of the atmosphere is the province of meteorology. Hence hydrology mostly deals with the land phase of the cycle.

The routes by which excess rainfall reaches the stream, how much does so, and at what time during a rain storm, form the study of hydrology. The rainfall is first intercepted by vegetation thus introducing a delay period, storage and evaporation. The net rainfall which reaches the soil behave in two possible ways infiltration or surface runoff. Surface runoff will dominate when the rainfall is heavy or when the soil is already soaked (saturated) or when the soil is fully compacted (inpermeable).

The infiltered water travels vertically until a less permeable horizon is reached when part of the water flows downslope in the soil as throughflow. Deeper percolation reaches the groundwater from which the excess water contributes to the background base-flow in to a stream.

The hydrological cycle can be studied at variety of scales: global, national, catchment or even smaller experimental scales. The study at a catchment scale is the more dominant one.

(4) Catchment and Run-off

The natural catchment has a cover of soils and vegetation and a foundation of various rock types. It is bounded by the watershed line which separates slopes which shed runoff to one catchment from those contributing to it's neighbour. The inputs of rainfall and solar energy into the catchment produces outputs of evapora tion, river flow and fluvial erosion.

River flow = Precipitation - Evapotranspiration

$\pm$ Changes in soil moisture and ground water.

The biggest conceptual problem in dealing with runoff from catchment is that the activities of the various process varies spatially over the catchment area, introducing delays, storages, losses and flows which then produce the pattern of the stream's response.

That response could be depicted by a hydrograph with distinctive rise and fall of river level which marks the passage of a flood. The graph of flow volume against time is called the hydrograph. The form of the hydrograph depends on the time over which the river is observed and how often the measurements are made (like temperature variation over a day or over an year).

It is usually the storm hydrographs which is important. As the water level in the stream changes through a storm, the patterns of flow change and this changes the resulting process. The river flow depends on the characteristics of rainfall and that of the surface.

Rainfall.	Surface.
Total amount	Total area.
Rate of fall	Relief.
Duration.	Shape of area.
	Vegetation.
	Type of soil or rock.

(5) Sedimenation.

The features which occur along the river channels are produced as a result of erosion and deposition. There are three types of sediment. Dissolved sold load, suspended load and bedload. The dissolved sold load and the suspended load can be measured easily but the bedload is difficult to measure.

Since the sediment load is essentially propelled by the water, inevitably the speed and depth of the water play an important role and these are closely associated with discharge. In general as discharge increase the suspended and bed sediment load increase but the concentration of the dissolved solid decreases.

(6) Drainage.

Drainage may defined as the removal of excess water from an area. The water may be from rainfall, flooding through streams and rivers, irrigation discharges.

Surface Drainage. - for storm water or irrigation.

Sub surface drainage - for control of groundwater.

Natural drianage.

Artificial drainage.

The problems of improper drainage are

a) Marshy lands.

b) Ponding or flooding.

c) Salt deposition.

d) Erosion of soil.

e) Deposition of silt (silting)

The benefits of drainage in agriculture:-

a) To maintain the supply of Oxygen.

b) Other associated facture are: Soil temperature resistance to and root growth, Chemical and biological conditions favorable to root growth.

c) Poor drainage discourages the of aerobic bacteria which are needed to provide nitrogen for crops.

d) For control of salinity and alkalinity.

e) Reduction or eliminiation of mosquito and other insect breading grounds.

(7) Problems of Drainage.

a) Stormwater drainage.
b) Road drainage.
c) Flood drainage.
d) Drainage for agriculture.
e) Drainage in coastal areas (Tidal)

The method adopted for solving drainage problem could be summarised as follows:

a) Pertinent data required
b) Where and how to obtain data.
c) How to record, present, analyse and apply these data
d) Forecasting drainage requirement
e) Drainage design criteria
f) Construction standards.

(8) Initial field study

a) Location and capacity of natural waterways
b) Location and condition of outlets
c) High water marks or other infomation on flood flows
d) Location and characteristics of ground water sources such as pond, wells springs, tanks etc.
e) Local irrigation practice such as method of water a application and efficiency of irrigation
f) Present cropping practices
g) Type, Location, spacing, depth and effectiveness any existing drains
h) Topographic features
i) Indications of salinity and alkalinity
j) Information on present water table levels, its fluctuation and direction of movement
k) Discussions with local people
l) Status and scope of any programme of government or other agencies.

(9) Drainage within Jaffna Peninsula

a) Topography

The area is generally flat and has historically carried it's own drainage with ponds and channels ingeniously planned and executed since dutch period, The ground altitude in most part of the peninsula does not vary much to cause sufficient slopes to allow quick disposal of storm water. The problem is further aggravated by the seasonal variation of the lagoon water levels. Therefore drainage problem demand carefully designed channels and outlets and should be maintained by regular de-silting of ponds and channels.

b) Road Drainage

Some of the present roads has been initially functioning as flood channels and now upgraded to carryout dual function of roadqay cum flood channel. If drainage along these roads are not provided by means of side drains

(c) Geology

The Jaffna peninsula with its limestone strata and with no highlands has a groundwater storage system different from the mainland. Further schemes have already been planned to convert some of the saline lagoons in the peninsula into fresh water storages in stages. Although this maynot have any direct bearing nevertheless any deainage policies and plans should be consistent with these schemes and terrain conditions.

(d) Deepening of Ponds

Pomd over-deepened unsc identifically could be detrimental to the area as some have expressed that this may puncture and make the area saline. However in general de-silting will have to be carriedout. Concrete posts may be erected at convenient spots in the ponds and determination of levels to which de-silting should be carriedout.

(e) Urbanisation

Due to urbanisation, paddy lands have been converted into dwelling places with or without or with partial filling. further some of the ponds have been closed and many have been reduced in area by encroachment.

(f) Drainage of Jaffna Municipal Area.

The JMC area is situated within the estuart of the drainage besin and hence the drainage is made more difficult by the flood of water contributed from outside the JMC limits.

The JMC area could be divided into ten catchment areas. There are about 12 drainage channels of which about 4 could be identified as main drainage channels. They take the storn water mainly to the Jaffna lagoon in the south. There are about 30 ponds which act as storages in draining the area. Traditionally some of these ponds served other needs as for example vannankulam for washing clothes, pillaiyar kulam for the temple, parawaikulam for agriculture etc.

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